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**Gong et al.**

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(54) **DEVICE, SYSTEM AND METHOD OF SCHEDULING COMMUNICATIONS WITH A GROUP OF WIRELESS COMMUNICATION UNITS**

(58) **Field of Classification Search**  
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**Related U.S. Application Data**

(57) **ABSTRACT**

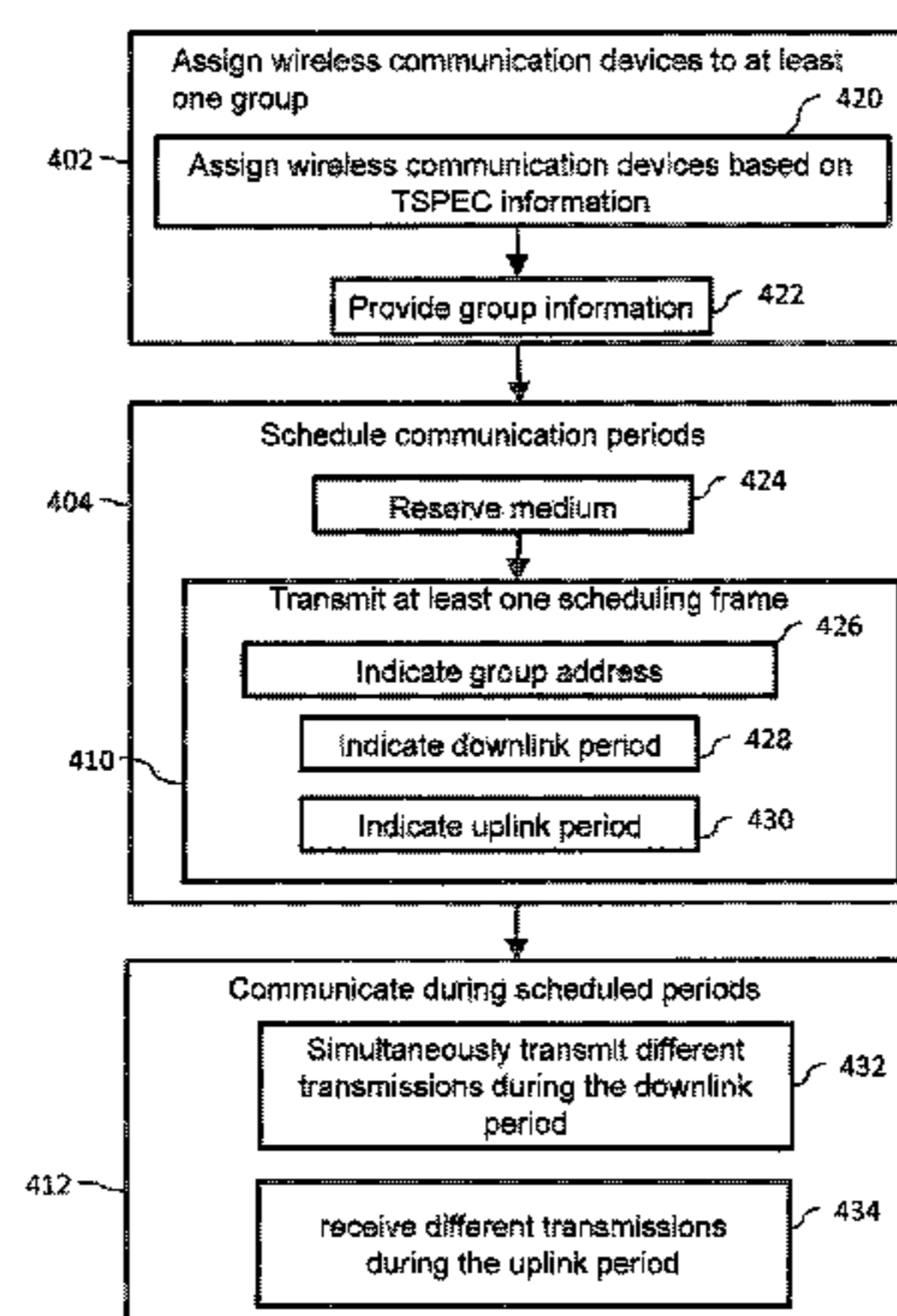
(63) Continuation of application No. 14/508,209, filed on Oct. 7, 2014, now Pat. No. 9,320,054, which is a (Continued)

Some demonstrative embodiments include devices, systems and/or methods of scheduling communications with a group of wireless communication devices. For example, a wireless communication unit may transmit at least one scheduling frame including an indication of a downlink period allocated for simultaneous transmission from the wireless communication unit to at least one group of a plurality of wireless communication devices, wherein the wireless communication unit is to simultaneously transmit a plurality of different wireless communication transmissions to the plurality of wireless communication devices of the group during the downlink period. Other embodiments are described and claimed.

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**16 Claims, 5 Drawing Sheets**



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continuation of application No. 13/755,395, filed on Jan. 31, 2013, now Pat. No. 8,897,185, which is a continuation of application No. 12/640,027, filed on Dec. 17, 2009, now abandoned.

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 See application file for complete search history.

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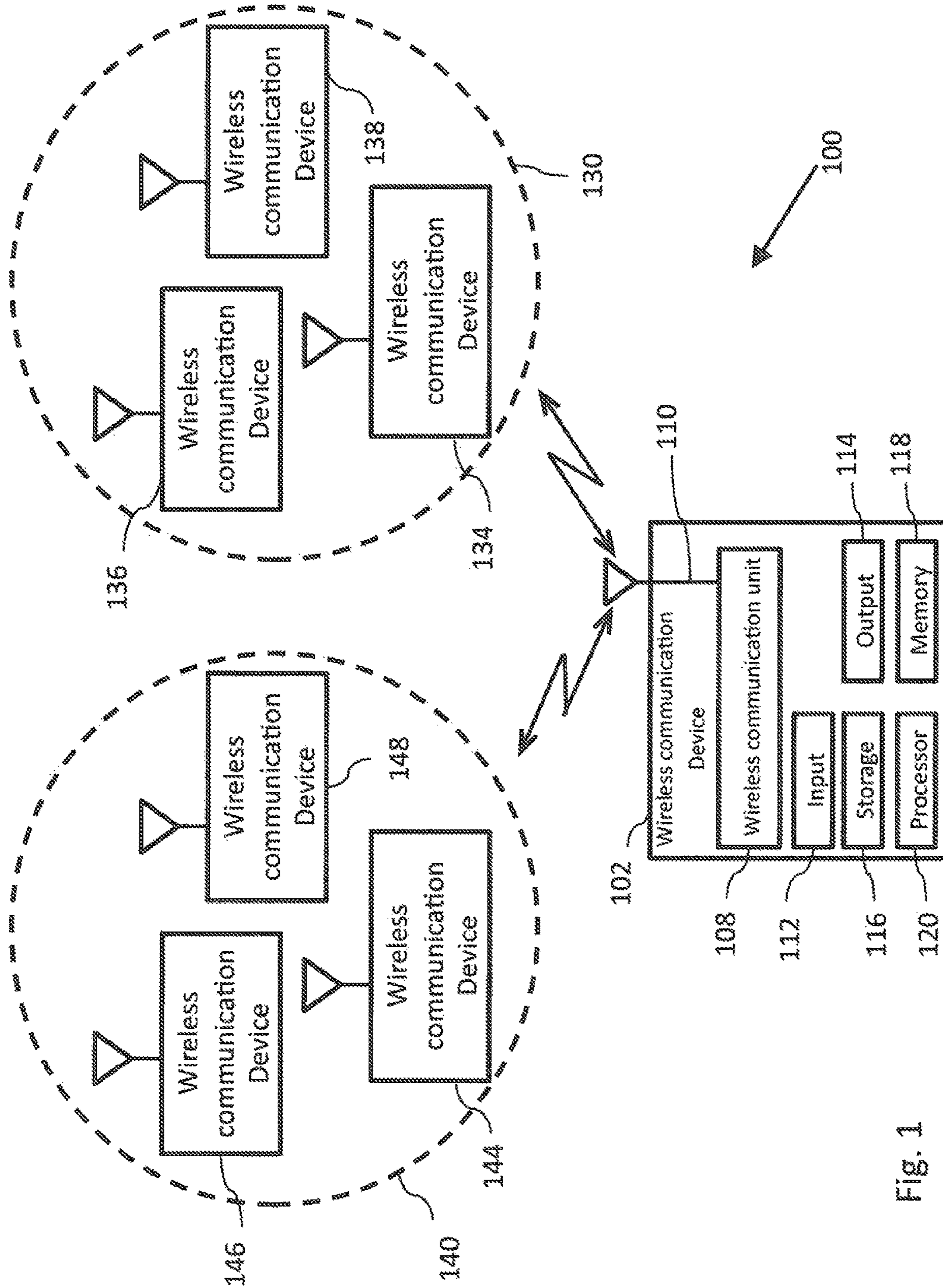


Fig. 1

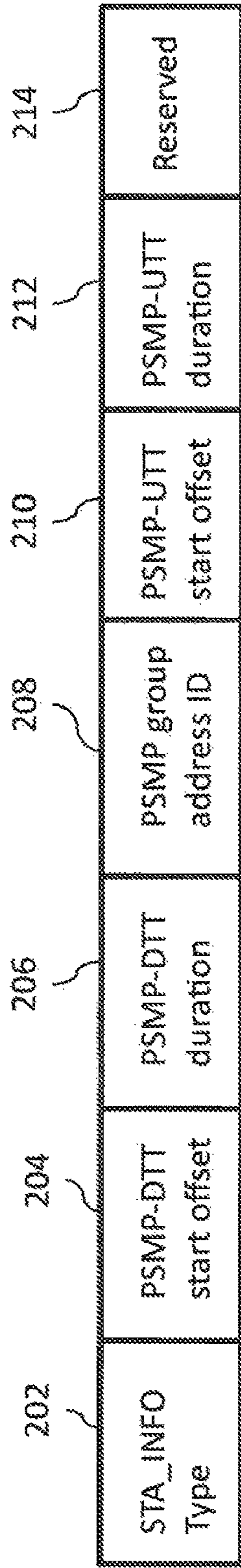


Fig. 2

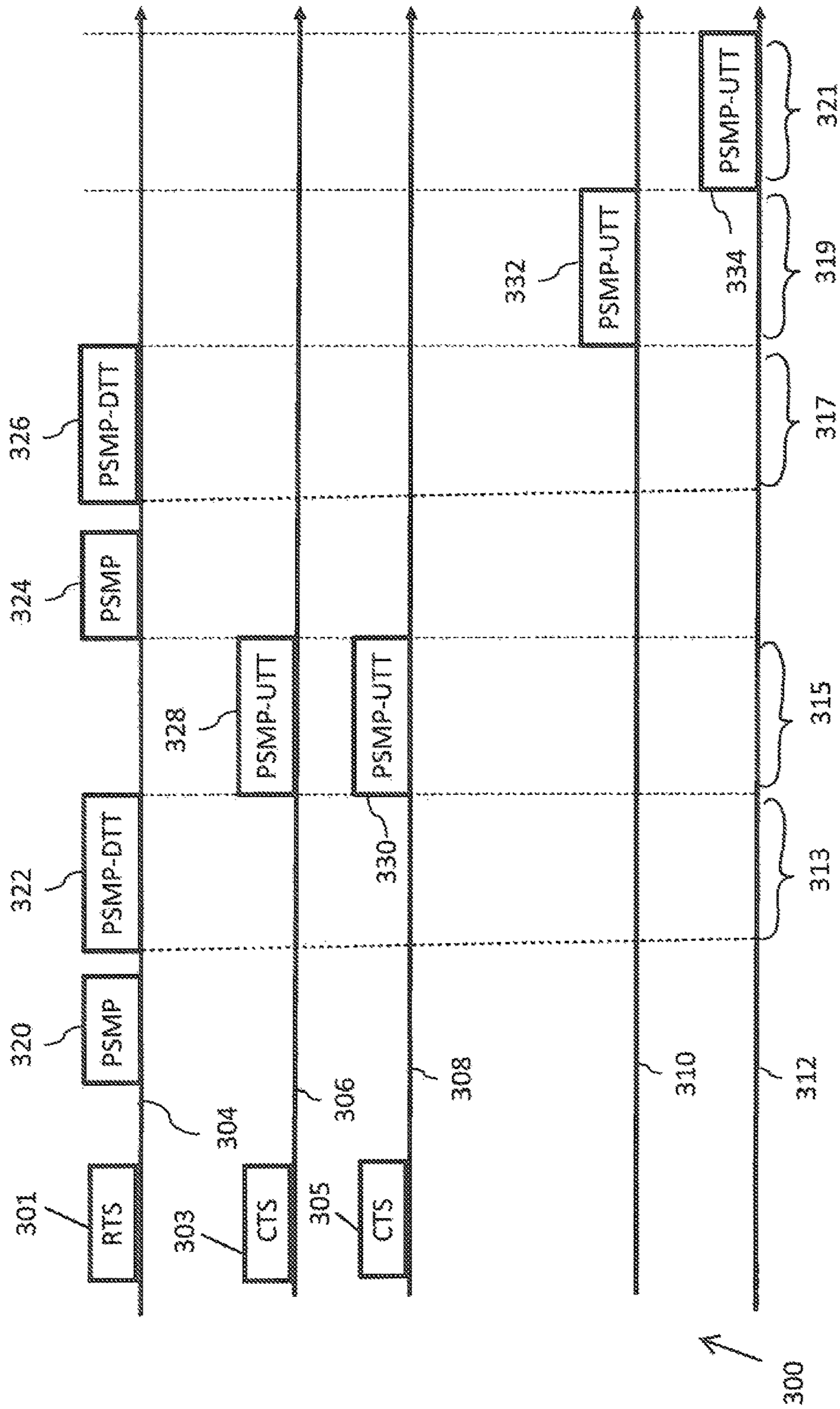


Fig. 3

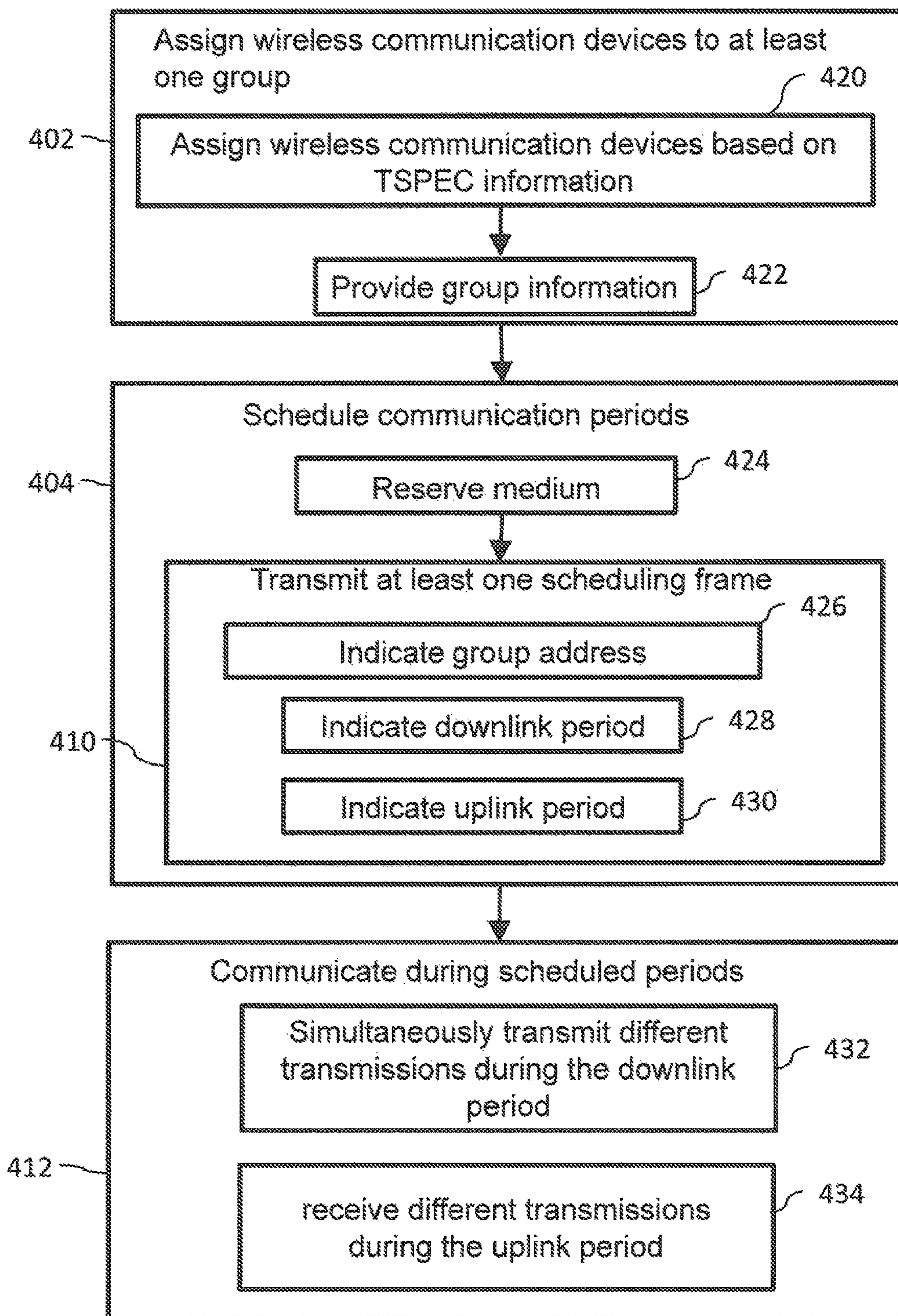


FIG. 4

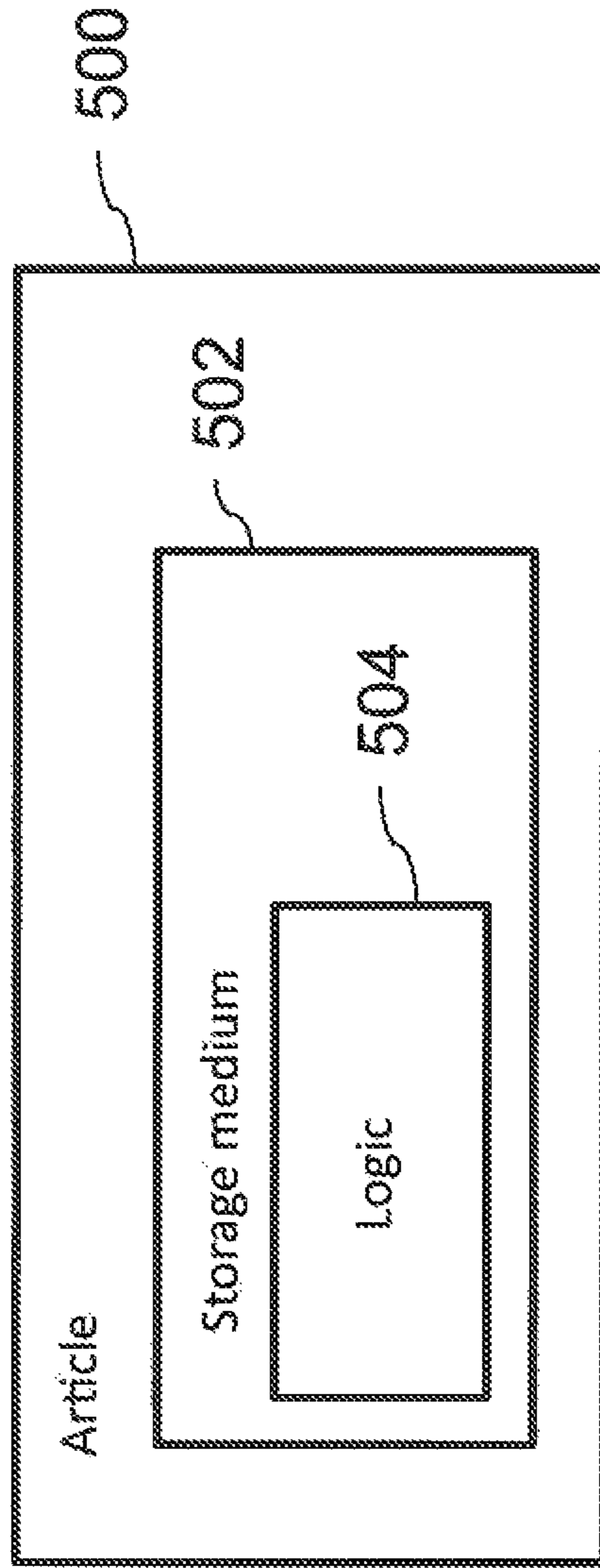


Fig. 5



**DEVICE, SYSTEM AND METHOD OF  
SCHEDULING COMMUNICATIONS WITH A  
GROUP OF WIRELESS COMMUNICATION  
UNITS**

CROSS-REFERENCE

This application is a Continuation Application of U.S. patent application Ser. No. 14/508,209, filed Oct. 7, 2014, which is a Continuation Application of U.S. patent application Ser. No. 13/755,395, filed Jan. 31, 2013, which is a Continuation Application of U.S. patent application Ser. No. 12/640,027, filed Dec. 17, 2009, the entire disclosures of which are incorporated herein by reference.

BACKGROUND

Some wireless communication devices and/or systems may implement suitable power saving schemes.

For example, according to a Power Save Multi-Poll (PSMP) scheme a first device, for example, a controller or a coordinator of a network, e.g., an Access Point (AP) of a Basic Service Set (BSS), may transmit to a second device, e.g., a station, a PSMP action frame scheduling one or more downlink time periods, during which the station is to be ready to receive transmissions from the AP, and/or one or more uplink time periods, during which the station may be allowed to transmit transmissions to the AP.

BRIEF DESCRIPTION OF THE DRAWINGS

For simplicity and clarity of illustration, elements shown in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements may be exaggerated relative to other elements for clarity of presentation. Furthermore, reference numerals may be repeated among the figures to indicate corresponding or analogous elements. The figures are listed below.

FIG. 1 is a schematic block diagram illustration of a system, in accordance with some demonstrative embodiments.

FIG. 2 is a schematic illustration of components of a scheduling frame, in accordance with some demonstrative embodiments.

FIG. 3 is a schematic illustration of a sequence of communications between a wireless communication device and at least one group of other wireless communication devices, in accordance with some demonstrative embodiments.

FIG. 4 is a schematic flow-chart illustration of a method of scheduling communications with a group of wireless communication devices, in accordance with some demonstrative embodiments.

FIG. 5 is a schematic illustration of an article of manufacture, in accordance with some demonstrative embodiments.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of some embodiments. However, it will be understood by persons of ordinary skill in the art that some embodiments may be practiced without these specific details. In other instances, well-known methods, procedures, components, units and/or circuits have not been described in detail so as not to obscure the discussion.

Discussions herein utilizing terms such as, for example, “processing”, “computing”, “calculating”, “determining”, “establishing”, “analyzing”, “checking”, or the like, may refer to operation(s) and/or process(es) of a computer, a computing platform, a computing system, or other electronic computing device, that manipulate and/or transform data represented as physical (e.g., electronic) quantities within the computer’s registers and/or memories into other data similarly represented as physical quantities within the computer’s registers and/or memories or other information storage medium that may store instructions to perform operations and/or processes.

The terms “power save” and “power save mode” as used herein may refer, for example, to reducing, diminishing, shutting down, powering off, turning off and/or switching off the electrical current to a device and/or component, and/or to switching the device and/or component to operate at a sleep mode, a reduced-power mode, a stand-by mode, an idle mode and/or any other operation mode, which consumes less power than required for full and/or normal operation of the device and/or component, e.g., for full reception, handling, decoding, transmitting and/or processing of wireless communication signals.

The terms “regular power” and “regular power mode” as used herein may refer, for example, to any operating mode enabling full reception and/or normal operation of a device and/or component, e.g., for full reception, handling, decoding, transmitting and/or processing of wireless communication signals.

Some embodiments may be used in conjunction with various devices and systems, for example, a Personal Computer (PC), a desktop computer, a mobile computer, a laptop computer, a notebook computer, a tablet computer, a server computer, a handheld computer, a handheld device, a Personal Digital Assistant (PDA) device, a handheld PDA device, an on-board device, an off-board device, a hybrid device, a vehicular device, a non-vehicular device, a mobile or portable device, a consumer device, a non-mobile or non-portable device, a wireless communication station, a wireless communication device, a wireless Access Point (AP), a wired or wireless router, a wired or wireless modem, a video device, an audio device, an audio-video (A/V) device, a Set-Top-Box (STB), a Blu-ray disc (BD) player, a BD recorder, a Digital Video Disc (DVD) player, a High Definition (HD) DVD player, a DVD recorder, a HD DVD recorder, a Personal Video Recorder (PVR), a broadcast HD receiver, a video source, an audio source, a video sink, an audio sink, a stereo tuner, a broadcast radio receiver, a flat panel display, a Personal Media Player (PMP), a digital video camera (DVC), a digital audio player, a speaker, an audio receiver, an audio amplifier, a gaming device, a data source, a data sink, a Digital Still camera (DSC), a wired or wireless network, a wireless area network, a Wireless Video Area Network (WVAN), a Local Area Network (LAN), a Wireless LAN (WLAN), a Personal Area Network (PAN), a Wireless PAN (WPAN), devices and/or networks operating in accordance with existing IEEE 802.11 (IEEE 802.11-1999: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications), 802.11a, 802.11b, 802.11g, 802.11h, 802.11j, 802.11n, 802.16, 802.16d, 802.16e, 802.16f, standards (“the IEEE 802 standards”) and/or future versions and/or derivatives thereof, devices and/or networks operating in accordance with existing Wireless-Gigabit-Alliance (WGA) and/or WirelessHD™ specifications and/or future versions and/or derivatives thereof, units and/or devices which are part of the above networks, one way and/or two-way radio communication systems,

cellular radio-telephone communication systems, a cellular telephone, a wireless telephone, a Personal Communication Systems (PCS) device, a PDA device which incorporates a wireless communication device, a mobile or portable Global Positioning System (GPS) device, a device which incorporates a GPS receiver or transceiver or chip, a device which incorporates an RFID element or chip, a Multiple Input Multiple Output (MIMO) transceiver or device, a Single Input Multiple Output (SIMO) transceiver or device, a Multiple Input Single Output (MISO) transceiver or device, a device having one or more internal antennas and/or external antennas, Digital Video Broadcast (DVB) devices or systems, multi-standard radio devices or systems, a wired or wireless handheld device (e.g., BlackBerry, Palm Treo), a Wireless Application Protocol (WAP) device, or the like.

Some embodiments may be used in conjunction with one or more types of wireless communication signals and/or systems, for example, Radio Frequency (RF), Infra Red (IR), Frequency-Division Multiplexing (FDM), Orthogonal FDM (OFDM), Time-Division Multiplexing (TDM), Time-Division Multiple Access (TDMA), Extended TDMA (E-TDMA), General Packet Radio Service (GPRS), extended GPRS, Code-Division Multiple Access (CDMA), Wideband CDMA (WCDMA), CDMA 2000, single-carrier CDMA, multi-carrier CDMA, Multi-Carrier Modulation (MDM), Discrete Multi-Tone (DMT), Bluetooth®, Global Positioning System (GPS), Wi-Fi, Wi-Max, ZigBee™, Ultra-Wideband (UWB), Global System for Mobile communication (GSM), 2G, 2.5G, 3G, 3.5G, Enhanced Data rates for GSM Evolution (EDGE), or the like. Other embodiments may be used in various other devices, systems and/or networks.

The term “wireless device” as used herein includes, for example, a device capable of wireless communication, a communication device capable of wireless communication, a communication station capable of wireless communication, a portable or non-portable device capable of wireless communication, or the like. In some demonstrative embodiments, a wireless device may be or may include a peripheral that is integrated with a computer, or a peripheral that is attached to a computer. In some demonstrative embodiments, the term “wireless device” may optionally include a wireless service.

Some demonstrative embodiments may be used in conjunction with suitable limited-range or short-range wireless communication networks, for example, a wireless area network, a “piconet”, a WPAN, a WVAN and the like.

Reference is now made to FIG. 1, which schematically illustrates a block diagram of a system **100** in accordance with some demonstrative embodiments.

In some demonstrative embodiments, system **100** may include a wireless area network and/or a Basic Service Set (BSS) including one or more wireless communication devices, e.g., wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138**, capable of communicating content, data, information and/or signals over one or more suitable wireless communication links, for example, a radio channel, an IR channel, a RF channel, a Wireless Fidelity (WiFi) channel, and the like. One or more elements of system **100** may optionally be capable of communicating over any suitable wired communication links.

In some demonstrative embodiments, wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may include, for example, a PC, a desktop computer, a mobile computer, a laptop computer, a notebook computer, a tablet computer, a server computer, a handheld computer, a handheld device, a PDA device, a handheld PDA device, an

on-board device, an off-board device, a hybrid device (e.g., combining cellular phone functionalities with PDA device functionalities), a consumer device, a vehicular device, a non-vehicular device, a mobile or portable device, a non-mobile or non-portable device, a cellular telephone, a PCS device, a PDA device which incorporates a wireless communication device, a mobile or portable GPS device, a DVB device, a relatively small computing device, a non-desktop computer, a “Carry Small Live Large” (CSLL) device, an Ultra Mobile Device (UMD), an Ultra Mobile PC (UMPC), a Mobile Internet Device (MID), an “Origami” device or computing device, a device that supports Dynamically Composable Computing (DCC), a context-aware device, a video device, an audio device, an A/V device, a STB, a BD player, a BD recorder, a DVD player, a HD DVD player, a DVD recorder, a HD DVD recorder, a PVR, a broadcast HD receiver, a video source, an audio source, a video sink, an audio sink, a stereo tuner, a broadcast radio receiver, a flat panel display, a PMP, a DVC, a digital audio player, a speaker, an audio receiver, a gaming device, an audio amplifier, a data source, a data sink, a DSC, a media player, a Smartphone, a television, a music player, or the like.

In some demonstrative embodiments, wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may include a wireless communication unit **108** to communicate with other wireless communication devices of system **100**, e.g., as described below. Wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may also include, for example, one or more of a processor **120**, an input unit **112**, an output unit **114**, a memory unit **118**, and a storage unit **116**. Wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may optionally include other suitable hardware components and/or software components.

In some demonstrative embodiments, some or all of the components of wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may be enclosed in a common housing or packaging, and may be interconnected or operably associated using one or more wired or wireless links. In other embodiments, components of wireless communication devices **102**, **144**, **146**, **148**, **134**, **136**, and/or **138** may be distributed among multiple or separate devices.

Processor **120** includes, for example, a Central Processing Unit (CPU), a Digital Signal Processor (DSP), one or more processor cores, a single-core processor, a dual-core processor, a multiple-core processor, a microprocessor, a host processor, a controller, a plurality of processors or controllers, a chip, a microchip, one or more circuits, circuitry, a logic unit, an Integrated Circuit (IC), an Application-Specific IC (ASIC), or any other suitable multi-purpose or specific processor or controller. Processor **120** executes instructions, for example, of an Operating System (OS) of wireless communication device **102**, and/or of one or more suitable applications.

Input unit **112** includes, for example, a keyboard, a keypad, a mouse, a touch-pad, a track-ball, a stylus, a microphone, or other suitable pointing device or input device.

Output unit **114** includes, for example, a monitor, a screen, a flat panel display, a Cathode Ray Tube (CRT) display unit, a Liquid Crystal Display (LCD) display unit, a plasma display unit, one or more audio speakers or earphones, or other suitable output devices.

Memory unit **118** includes, for example, a Random Access Memory (RAM), a Read Only Memory (ROM), a Dynamic RAM (DRAM), a Synchronous DRAM (SDRAM), a flash memory, a volatile memory, a non-volatile memory, a cache memory, a buffer, a short term memory

unit, a long term memory unit, or other suitable memory units. Storage unit **116** includes, for example, a hard disk drive, a floppy disk drive, a Compact Disk (CD) drive, a ROM drive, a DVD drive, or other suitable removable or non-removable storage units. Memory unit **118** and/or storage unit **116**, for example, may store data processed by wireless communication device **102**.

In some demonstrative embodiments, wireless communication unit **108** includes, for example, one or more wireless transmitters, receivers and/or transceivers able to send and/or receive wireless communication signals, RF signals, frames, blocks, transmission streams, packets, messages, data items, and/or data. For example, wireless communication unit **108** may include or may be implemented as part of a wireless Network Interface Card (NIC), and the like.

Wireless communication unit **108** may include, or may be associated with, one or more antennas or one or more sets of antennae **110**. Antennae **110** may include, for example, an internal and/or external RF antenna, a dipole antenna, a monopole antenna, an omni-directional antenna, an end fed antenna, a circularly polarized antenna, a micro-strip antenna, a diversity antenna, or other type of antenna suitable for transmitting and/or receiving wireless communication signals, blocks, frames, transmission streams, packets, messages and/or data.

In some demonstrative embodiments, at least one of the wireless communication devices of system **100**, for example, wireless communication device **102**, may perform the functionality of an Access Point (AP), Control Point (CP), Base Station (BS) or any coordinator or controller, e.g., as defined by the IEEE 802.11 and/or WGA specifications.

In some demonstrative embodiments, wireless communication unit **108** may be capable of simultaneously transmitting transmissions to two or more other devices of system **100** and/or simultaneously receiving transmissions from two or more other devices of system **100**.

In some embodiments, wireless communication unit **108** may be capable of performing Spatial Division Multiple Access (SDMA) communication. For example, wireless communication unit **108** may transmit a downlink SDMA transmission by transmitting different signals substantially simultaneously via antennae **110**, such that the combined transmitted signals result in different signals, which are intended to be received by two or more other wireless communication devices of system **100**, being transmitted substantially in different directions on the same frequency.

In some demonstrative embodiments, wireless communication unit **108** may receive an uplink SDMA transmission including different signals from two or more other devices of system **100**.

The term “substantially simultaneously”, as used herein with reference to transmitting to two or more different wireless communication devices and/or receiving from two or more wireless communication devices, may refer to transmitting and/or receiving two or more transmissions, wherein at least a portion of each transmission and/or reception occurs at the same time, but does not imply that the different transmissions and/or receptions must start and/or end at the same time, although they may.

In some demonstrative embodiments, wireless communication unit **108** may communicate with at least one group of a plurality of wireless communication devices of system **100**, for example, groups **130** and/or **140**, e.g., as described in detail below.

In some demonstrative embodiments, group **140** may include a first plurality of wireless communication devices

of system **100**, e.g., wireless communication devices **144**, **146** and/or **148**, which may be suitable for simultaneous downlink and/or uplink wireless communication with wireless communication unit **108**; and/or group **130** may include a second plurality of wireless communication devices of system **100**, e.g., wireless communication devices **134**, **136** and/or **138**, which may be suitable for simultaneous downlink and/or uplink wireless communication with wireless communication unit **108**. For example, groups **130** and/or **140** may include SDMA groups of devices suitable for unidirectional, e.g., in an uplink direction to device **102** and/or a downlink direction from device **102**, and/or bidirectional SDMA communication with wireless communication unit **108**, e.g., as described below.

In some demonstrative embodiments, the wireless communication devices of groups **130** and/or **140** may be grouped together, e.g., by wireless communication unit **108**, according to any suitable criteria, for example, one or more traffic-specification (TSPEC) requirements, e.g., quality of service requirements, bandwidth requirements, traffic pattern requirements, and the like, and/or any other suitable requirement and/or parameter.

In some demonstrative embodiments, wireless communication unit **108** may be capable of receiving the TSPEC information corresponding to wireless communication devices **144**, **146**, **148**, **134**, **136**, and/or **138** as a part of an Add Traffic Stream (ADDTS) Request frame. The ADDTS frame received from a wireless communication device may include a suitable TSPEC Information Element (IE) and/or field, which may include the TSPEC information corresponding to the wireless communication device. In other embodiments, wireless communication unit **108** may receive the TSPEC information as part of any other suitable frame and/or communication and/or in any other suitable format.

In some demonstrative embodiments, the TSPEC information corresponding to a wireless communication device, as received by wireless communication unit **108**, may include traffic flow information defining a traffic flow between the wireless communication device and wireless communication unit **108**. The TSPEC information corresponding to the wireless communication device may include, for example, one or more of a traffic pattern of the traffic flow, a Quality of Service (QoS) of the traffic flow, and/or any other series of requirements, parameters, characteristics and/or expectations of a traffic flow. For example, wireless communication unit **108** may receive a first ADDTS frame from wireless communication device **144**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **144** and wireless communication unit **108**; a second ADDTS frame from wireless communication device **146**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **146** and wireless communication unit **108**; a third ADDTS frame from wireless communication device **148**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **148** and wireless communication unit **108**; a fourth ADDTS frame from wireless communication device **134**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **134** and wireless communication unit **108**; a fifth ADDTS frame from wireless communication device **136**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **136** and wireless communication unit **108**; and/or a sixth

ADDTs frame from wireless communication device **138**, including traffic flow information, e.g., a traffic pattern and/or a QoS, defining a traffic flow between wireless communication device **138** and wireless communication unit **108**.

In some demonstrative embodiments, the TSPEC information, received by wireless communication unit **108** from a wireless communication device, may include a directionality of the traffic flow between the wireless communication device and wireless communication unit **108**. The directionality of the traffic flow may be determined, for example, based on the traffic pattern of the traffic flow. For example, the directionality of the traffic flow may include an uplink traffic flow, e.g., including uplink transmissions from the wireless communication device to wireless communication unit **108**; a downlink traffic flow, e.g., including downlink transmissions from wireless communication unit **108** to the wireless communication device; or a bidirectional traffic flow, e.g., including both uplink transmissions and downlink transmissions.

In some demonstrative embodiments, the QoS of the traffic flow may include, for example, a QoS parameter representing, for example, a priority type of the traffic flow, e.g., guaranteeing a certain level of performance. The priority type of the traffic flow may be selected, for example, from a set of predefined priority types. In one example, the QoS of the traffic flow may be selected from a set of four predefined priority types, for example, a video priority type, an audio (voice) priority type, a best effort priority type, and a background priority type, e.g., as defined by the 802.11 standard and/or any other suitable standard.

In some demonstrative embodiments, the traffic flow corresponding to a wireless communication device may be categorized as an isochronous traffic flow, for example, if the traffic flow includes a time-dependent traffic flow, e.g., including video and/or voice data; and/or as an asynchronous traffic flow, for example, if the traffic flow is not time-dependent, e.g., if the traffic flow does not include video or voice data.

In some demonstrative embodiments, wireless communication unit **108** may assign wireless communication devices **144**, **146** and/or **148** to one or more groups, e.g., including group **140**, based on the categorization and/or directionality of the traffic flows corresponding to wireless communication devices **144**, **146** and/or **148**; and/or assign wireless communication devices **134**, **136** and/or **138** to one or more groups, e.g., including group **130**, based on the categorization and/or directionality of the traffic flows corresponding to wireless communication devices **134**, **136** and/or **138**.

In some demonstrative embodiments, wireless communication unit **108** may assign wireless communication devices **134**, **136**, **138**, **144**, **146** and/or **148** to an uplink isochronous group, a downlink isochronous group, a bidirectional isochronous group, and/or a bi-directional asynchronous group. In other embodiments, wireless communication unit **108** may assign wireless communication devices **134**, **136**, **138**, **144**, **146** and/or **148** to any other suitable group.

In some demonstrative embodiments, wireless communication unit **108** may assign a wireless communication device of devices **134**, **136**, **138**, **144**, **146** and/or **148** to the uplink isochronous group, for example, if the TSPEC information corresponding to the wireless communication device represents an uplink traffic pattern including at least one of video and voice data; wireless communication unit **108** may assign the wireless communication device to the downlink isochronous group if the TSPEC information corresponding to the wireless communication device represents a downlink traffic

pattern including at least one of video and voice data; wireless communication unit **108** may assign the wireless communication device to the bi-directional isochronous group if the TSPEC information corresponding to the wireless communication device represents a bidirectional traffic pattern including at least one of video and voice data; and/or wireless communication unit **108** may assign the wireless communication device to the bi-directional asynchronous group if the TSPEC information corresponding to the wireless communication device represents another traffic pattern.

Although some embodiments are described herein with reference to assigning a wireless communication device to a group based on the TSPEC information corresponding to the wireless communication device, other embodiments may include one or more wireless communication devices assigned to a group based on any other suitable criteria.

In some demonstrative embodiments, wireless communication unit **108** may assign wireless communication devices **144**, **146** and **148** to group **140** and provide to wireless communication devices **144**, **146** and **148** suitable group allocation information defining group **140** and/or relating to group **140**; and/or assign wireless communication devices **134**, **136** and **138** to group **130** and provide to wireless communication devices **134**, **136** and/or **138** suitable group allocation information defining group **130** and/or relating to group **130**.

In some demonstrative embodiments, wireless communication unit **108** may assign to groups **140** and/or **130** respective wireless communication addresses (also referred to as “group address” or “multicast address”). The group address assigned to each of groups **140** and/or **130** may include, for example, a suitable Media-Access-Control (MAC) address or a multicast address, which may be assigned uniquely, e.g., within system **100** and/or a Basic-Service-Set (BSS) controlled and/or managed by wireless communication unit **108**.

In some demonstrative embodiments, wireless communication unit **108** may inform wireless communication devices **144**, **146** and/or **148** of the group address assigned to group **140**, and/or may inform wireless communication devices **134**, **136** and/or **138** of the group address assigned to group **130**, for example, by using any suitable transmission, frame and/or packet. For example, wireless communication unit **108** may transmit one or more unicast frames to wireless communication devices **144**, **146**, **148**, **134**, **136** and/or **138** e.g., a first group allocation frame addressed to wireless communication device **144**, a second group allocation frame addressed to wireless communication device **146**, a third group allocation frame addressed to wireless communication device **148**, a fourth group allocation frame addressed to wireless communication device **134**, a fifth group allocation frame addressed to wireless communication device **136** and/or a sixth group allocation frame addressed to wireless communication device **138**. The first, second and third group allocation frames may include, for example, the group address of group **140** and the fourth, fifth and sixth group allocation frames may include, for example, the group address of group **130**.

In some demonstrative embodiments, wireless communication unit **108** may determine, e.g., based on any suitable criteria, an order at which wireless communication devices **144**, **146**, **148**, **134**, **136** and/or **138** are to respond to a transmission from wireless communication unit **108**, for example, such that wireless communication devices **144**, **146**, **148**, **134**, **136** and/or **138** may respond during non-overlapping time periods, e.g., as described below. For example, after assigning wireless communication devices

144, 146, 148 to group 140, wireless communication unit 108 may determine that wireless communication device 144 is to respond to the transmission from wireless communication unit 108 a first offset time after the transmission from wireless communication unit 108, that wireless communication device 146 is to respond to the transmission from wireless communication unit 108 a second offset time, which is longer than the first offset time after the transmission, and/or that wireless communication device 148 is to respond to the transmission from wireless communication unit 108 a third offset time, which is longer than the second offset time after the transmission. A difference between the second and first offset times and/or difference between the third and second offset times may be at least equal to a duration of the responses from wireless communication devices 144 and/or 146, e.g., to allow wireless communication devices 144, 146 and 148 to respond during non-overlapping periods.

In some demonstrative embodiments, wireless communication unit 112 may include an indication of the required order, for example, in the group allocation frame, e.g., as part of a predefined field (“the Device Association Identifier (AID) list field”). For example, the group allocation frame transmitted to devices 144, 146 and/or 148 may include values representing wireless communication devices 144, 146 and 148 according to the required order. For example, the group allocation frame may include, e.g., in AID list field, a value representing the MAC address of wireless communication device 146 followed by a value representing the MAC address of wireless communication device 144, which in turn may be followed by a value representing the MAC address of wireless communication device 148, e.g., if wireless communication device 146 is to respond to wireless communication unit 108 prior to a response from wireless communication device 144, which in turn is to respond to wireless communication unit 108 prior to a response from wireless communication device 148.

In some demonstrative embodiments, wireless communication devices 144, 146 and/or 148 may each determine the order at which to respond to wireless communication unit 108, based on the indication of the required order.

In some embodiments, wireless communication devices 144, 146 and/or 148 may transmit the responses at a data rate equal to a data rate of the transmission from wireless communication unit 108, e.g., in order to allow wireless communication devices 144, 146 and/or 148 to schedule the transmission of the responses, such that wireless communication device 108 may be able to receive the responses.

In another embodiment, wireless communication devices 144, 146 and/or 148 may transmit the responses at a selected predefined data rate for communication with wireless communication unit 108. In one example, wireless communication devices 144, 146 and/or 148 may transmit the responses at a data rate, which is selected from a predefined set of data rates implemented for communication in system 100, e.g., the BSSBasicRateSet as defined by the 802.11 standards. For example, wireless communication devices 144, 146 and/or 148 may transmit the responses at a highest data rate of the BSSBasicRateSet, which is less than or equal to a rate of an immediately previous frame received from wireless communication unit 108.

In some demonstrative embodiments, wireless communication unit 108 may assign wireless communication devices 144, 146 and/or 148 to group 140, and/or assign wireless communication devices 134, 136 and/or 138 to group 130, for example, while not directly providing wireless communication devices 144, 146 and/or 148 with information

defining and/or relating to group 140 and/or not directly providing wireless communication devices 134, 136 and/or 138 with information defining and/or relating to group 130. According to this example, wireless communication unit 108 may simultaneously transmit downlink transmissions to devices of group 140 and/or 130, e.g., while one or more of the wireless communication devices of group 140 and/or 130 may not be aware of the simultaneous transmission to other devices in group 140 and/or 130, respectively, for example, if the one or more wireless communication devices are not required to and/or is not able to transmit uplink SDMA transmissions to wireless communication unit 108. For example, wireless communication unit 108 may transmit a downlink SDMA transmission to a wireless communication device, e.g., device 148, while the wireless communication device may not be aware to the fact that the downlink transmission is a downlink transmission, for example, if wireless communication device 148 is not required to and/or is not able to transmit uplink SDMA transmissions to wireless communication unit 108.

In some demonstrative embodiments, wireless communication unit 108 may schedule simultaneous uplink and/or downlink transmissions between wireless communication unit 108 and the wireless communication devices of a group (“the scheduled group”) of groups 130 and/or 140, for example, according to any suitable power management scheme, e.g., a Power Save Multi-Poll (PSMP) scheme, and the like.

In some demonstrative embodiments, wireless communication unit 108 may transmit at least one scheduling frame, defining one or more uplink and downlink time periods, to the wireless communication devices of the scheduled group, e.g., as described below.

In some demonstrative embodiments, the scheduling frame may include any suitable power-management control frame, e.g., a PSMP activation frame, and the like. The scheduling frame may schedule at least one downlink transmission period, e.g., a PSMP downlink transmission (PSMP-DTT) period, during which wireless communication unit 108 may transmit simultaneous transmissions to wireless communication devices of the scheduled group; and/or at least one uplink transmission period, e.g., a PSMP uplink transmission (PSMP-UTT) period, during which wireless communication unit 108 is to receive uplink communications, e.g., sequentially and/or simultaneously, from wireless communication devices of the scheduled group, e.g., as described below.

In some demonstrative embodiments, wireless communication unit 108 may use the scheduling frame as part of the power management scheme, for example, to manage the scheduling of power save periods at one or more wireless communication devices of the scheduled group, e.g., between the downlink and/or uplink transmissions. For example, wireless communication unit 108 may transmit to the wireless communication devices of group 140 a scheduling frame instructing the wireless communication devices of group 140 to operate, during the one or more scheduled downlink periods, at a power mode, e.g., a regular power mode, at which the devices of group 140 are capable of receiving communications from wireless communication unit; and/or informing the wireless communication devices of group 140 of the one or more uplink periods, during which the wireless communication devices of group 140 may be allowed to transmit uplink transmissions to wireless communication unit 108. In one example, wireless communication unit 108 may transmit to the wireless communication devices of group 140 a scheduling frame defining a

downlink period beginning within 5 milliseconds (ms), e.g., with reference to any suitable reference time point, and lasting 10 ms; and/or an uplink beginning within 60 ms and lasting 20 ms. According to this example, wireless communication devices **144**, **146** and/or **148** may switch to a power save mode during a time period between 15<sup>th</sup> ms and the 60<sup>th</sup> ms. One or more wireless communication devices of the scheduled group may switch back to the regular power mode, e.g., before or at the end of the power save period.

In some demonstrative embodiments, wireless communication unit **108** may transmit one or more scheduling frames to schedule uplink and/or downlink periods corresponding to two or more groups, e.g., groups **130** and **140**. In one embodiment, wireless communication unit **108** may transmit a common scheduling frame to schedule different uplink and/or downlink periods for groups **130** and **140**. For example, the scheduling frame may include an indication of group **130**, e.g., the group address assigned to group **130**, which may be associated with an indication of first uplink and/or downlink periods scheduled for group **130**; an indication of group **140**, e.g., the group address assigned to group **140**, which may be associated with an indication of first uplink and/or downlink periods scheduled for group **140**. In another embodiment, wireless communication unit **108** may transmit different scheduling frames to the wireless communication devices of different groups of wireless communication devices, to notify the wireless communication devices of the different groups of different scheduled simultaneous downlink and/or uplink periods. For example, wireless communication unit **108** may transmit a first scheduling frame to wireless communication devices **144**, **146** and **148** of group **140**, defining the downlink and/or uplink periods for group **140**; and/or a second scheduling frame to wireless communication devices **134**, **136** and **138** of group **130**, defining the downlink and/or uplink periods transmission for group **130**.

Reference is now made to FIG. 2, which schematically illustrates components of a PSMP frame **200**, in accordance with some demonstrative embodiments. In some embodiments, one or more components of frame **200** may be included as part of the scheduling frame transmitted by wireless communication unit **108** (FIG. 1), e.g., as part of a PSMP scheme.

In some demonstrative embodiments, the components shown in FIG. 2 may be transmitted as part of any suitable frame, packet and/or transmission, e.g., as a data portion of a PSMP frame.

In some demonstrative embodiments, PSMP frame **200** may include a suitable STA\_INFO type field **202**.

In some demonstrative embodiments, PSMP frame **200** may include a PSMP downlink transmission (PSMP-DTT) start offset field **204** to indicate the time of initiation of a PSMP-DTT period, e.g., with reference to any suitable reference time. For example, wireless communication unit **108** (FIG. 1) may transmit PSMP frame **200** to wireless communication devices **144**, **146** and **148** of group **140** (FIG. 1), including PSMP-DTT start offset field **204** having a value indicating that the simultaneous PSMP DTT period scheduled for wireless communication devices **144**, **146** and **148** (FIG. 1) will commence in 10 ms.

In some demonstrative embodiments, PSMP frame **200** may include a PSMP-DTT duration field **206** to indicate the duration of the PSMP DTT period. For example, a value of 6 in PSMP-DTT duration field **206** may indicate that the PSMP DTT scheduled for wireless communication devices **144**, **146** and **148** of group **140** (FIG. 1), will last for 6 ms.

In some demonstrative embodiments, PSMP frame **200** may include at least one PSMP uplink transmission (PSMP-UTT) start offset field **210**, to indicate the time of initiation of at least one PSMP UTT period, respectively. For example, wireless communication unit **108** (FIG. 1) may transmit PSMP frame **200** to wireless communication devices **144**, **146** and **148** of group **140** (FIG. 1), including PSMP-UTT start offset field **210** indicating that the PSMP UTT period for transmissions from wireless communication devices **144**, **146** and **148** (FIG. 1) will commence in 10 ms, e.g., if wireless communication devices **144**, **146** and **148** (FIG. 1) support uplink SDMA transmissions. Alternatively, wireless communication unit **108** (FIG. 1) may transmit to each of wireless communication devices **144**, **146** and **148** (FIG. 1) PSMP frame **200** including a different PSMP-UTT start offset value, for example, such that each of wireless communication devices **144**, **146** and **148** (FIG. 1) may perform the PSMP UTT during non-overlapping time periods, e.g., if wireless communication devices **144**, **146** and **148** (FIG. 1) do not support uplink SDMA transmissions.

In some demonstrative embodiments, PSMP frame **200** may include at least one PSMP-UTT duration field **212**, to indicate the duration time of the at least one PSMP UTT period, respectively. For example, a value of 6 in PSMP-UTT duration field **212** may indicate that the PSMP UTT period is scheduled to last for 6 ms.

In some demonstrative embodiments, PSMP frame **200** may include an address ID field **208** (also referred to as “receiver address field”), to identify one or more wireless communication devices intended to receive PSMP frame **200**.

In one embodiment, field **208** may represent the group address or multicast address assigned to the scheduled group, e.g., as described above, for example, if wireless communication unit **108** (FIG. 1) transmits frame **200** to the group of wireless communication devices as part of a broadcast transmission. In one example, field **208** may have a size of 43 bits and wireless communication unit **108** (FIG. 1) may include in field **208** 43 bits, e.g., the 43 least-significant-bits (LSBs), of the group MAC address assigned to the scheduled group.

In another embodiment, PSMP group address ID **208** may represent a unicast address of a specific wireless communication device, e.g., wireless communication devices **144** intended to receive PSMP frame **200**, e.g., if wireless communication unit **108** (FIG. 1) transmits frame **200** to a single wireless communication device as part of a unicast transmission. For example, wireless communication unit **108** (FIG. 1) may transmit three unicast transmissions including frame **200** addressed to wireless communication devices **144**, **146** and **148** (FIG. 1), respectively.

In another embodiment, PSMP frame **200** may include a ID field **208** including a plurality of group addresses corresponding to a plurality of groups, e.g., two group address corresponding to groups **130** and **140**, respectively. According to this embodiment, PSMP frame **200** may include a first set of PSMP-DTT and/or PSMP-UTT values defining one or more PSMP DTT and/or UTT periods scheduled for a first group of the plurality of groups; followed by a second set of PSMP-DTT and/or PSMP-UTT values defining one or more PSMP DTT and/or UTT periods scheduled for a second group of the plurality of groups, and so on.

In some demonstrative embodiments, PSMP frame **200** may include a reserved field **214** to include any suitable additional information.

In some demonstrative embodiments, fields **210** and **212** may define a common PSMP UTT period, during which the

wireless communication devices of the scheduled group may simultaneously perform uplink transmissions, for example, if the wireless communication devices of the scheduled group support uplink SDMA transmission. For example, wireless communication unit **108** (FIG. 1) may transmit PSMP scheduling frame **200** to wireless communication devices **144**, **146** and/or **148** (FIG. 1), including fields **210** and **212** defining at least one PSMP-UTT period scheduled for transmissions from wireless communication devices **144**, **146** and/or **148** (FIG. 1) to wireless communication unit **108** (FIG. 1), e.g., if wireless communication devices **144**, **146** and/or **148** (FIG. 1) support uplink SDMA transmission.

In some demonstrative embodiments, fields **210** and **212** may define a plurality of PSMP UTT periods, during which the wireless communication devices of the scheduled group may sequentially perform uplink transmissions, for example, if the wireless communication devices of the scheduled group do not support uplink SDMA transmission. For example, wireless communication unit **108** (FIG. 1) may define the order at which a plurality of PSMP UTT periods are to be scheduled to wireless communication devices **134**, **136** and/or **138** of group **130** (FIG. 1), e.g., if wireless communication devices **134**, **136** and/or **138** of group **130** (FIG. 1) do not support uplink SDMA transmissions. Wireless communication unit **108** (FIG. 1) may define the order using, for example, the AID list filed, e.g., as described above. Wireless communication unit **108** (FIG. 1) may transmit PSMP scheduling frame **200** to wireless communication devices **134**, **136** and/or **138** (FIG. 1), including field **210** and **212** defining the beginning and duration of a first PSMP UTT period scheduled for transmission by a first device of group **130** (FIG. 1), e.g., determined according to the AID list; a second PSMP UTT period scheduled for transmission by a second device of group **130** (FIG. 1), e.g., according to the AID list, may begin after the first PSMP period and may last for the duration indicated by field **210**, and so on.

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may transmit some or all of the components of PSMP frame **200** to wireless communication devices of the scheduled group. For example, wireless communication unit **108** (FIG. 1) may transmit to a wireless communication device the PSMP frame **200** including PSMP-DTT start offset field **204**, PSMP-DTT duration field **206** and PSMP group address ID **208**, while not including fields **210** and/or **212**, for example, if the wireless communication device is not scheduled to perform uplink transmission to wireless communication unit **108** (FIG. 1).

Reference is now made to FIG. 3, which schematically illustrates a sequence **300** of transmissions between a wireless communication device, e.g., wireless communication device **102** (FIG. 1) and/or wireless communication unit **108** (FIG. 1), and one or more groups of other wireless communication devices, e.g., groups **140** and/or **130** (FIG. 1), in accordance with some demonstrative embodiments.

As shown in FIG. 3, a timeline **304** includes transmissions by the wireless communication device, e.g., wireless communication unit **108** (FIG. 1); a timeline **306** includes transmissions by a first wireless communication device of a first group, e.g., wireless communication device **144** (FIG. 1) of group **140** (FIG. 1); a timeline **308** includes transmissions by a second wireless communication device of the first group, e.g., wireless communication device **146** (FIG. 1) of group **140** (FIG. 1); a timeline **310** includes transmissions by a first wireless communication device of a second group, e.g., wireless communication device **134** (FIG. 1) of group **130** (FIG. 1); and a timeline **312** includes transmissions by

a second wireless communication device of the second group, e.g., wireless communication device **136** (FIG. 1) of group **130** (FIG. 1).

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may transmit a first PSMP scheduling frame **320** to the two or more wireless communication devices of the first group to schedule at least one simultaneous downlink transmission period **322** and/or at least one uplink transmission period **315** for the wireless communication devices of the first group. According to some embodiments, PSMP frame **320** may include some or all of the components of PSMP frame **200** (FIG. 2).

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may simultaneously transmit downlink transmissions **322** to two or more wireless communication devices of the first group during period **313**. For example, downlink transmissions **322** may be transmitted in the form of a downlink SDMA transmission. For example, wireless communication unit **108** (FIG. 1) may simultaneously transmit two or more different downlink transmissions **322** to the two or more wireless communication devices of the first group, e.g., to two or more of wireless communication devices **144**, **146** and **148** (FIG. 1).

In some demonstrative embodiments, the two or more wireless communication devices of the first group may simultaneously transmit, during period **315**, uplink transmissions **328** and **330**, respectively to wireless communication unit **108** (FIG. 1). For example, transmissions **328** and **330** may be transmitted in the form of an uplink SDMA transmission.

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may schedule one or more sequential uplink transmission periods, during which two or more wireless communication devices of a group, e.g., the second group, may sequentially transmit uplink transmissions to wireless communication unit **108** (FIG. 1), for example, if the wireless communication devices of the second group do not support uplink SDMA transmission.

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may transmit a second PSMP scheduling frame **324** to the two or more wireless communication devices of the second group to schedule at least one simultaneous downlink transmission period **317** and/or uplink transmission periods **319** and/or **321** for the wireless communication devices of the second group. According to some embodiments, PSMP frame **324** may include some or all of the components of PSMP frame **200** (FIG. 2).

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may simultaneously transmit downlink transmissions **326** to two or more wireless communication devices of the second group during period **317**. For example, downlink transmissions **326** may be transmitted in the form of a downlink SDMA transmission. For example, wireless communication unit **108** (FIG. 1) may simultaneously transmit two or more different downlink transmissions **326** to the two or more wireless communication devices of the second group, e.g., to two or more of wireless communication devices **134**, **136** and **138** (FIG. 1).

In some demonstrative embodiments, the two or more wireless communication devices of the second group, e.g., wireless communication devices **134** and/or **136** of group **130** (FIG. 1) may transmit uplink SDMA transmissions, **332** and **334**, respectively, to wireless communication unit **108** (FIG. 1) during non-overlapping time periods **319** and **321**, respectively.

In some demonstrative embodiments, wireless communication device **108** (FIG. 1) may reserve a wireless commu-

nication medium for a time period (“the reserved time period”) including at least the transmission period of the scheduling frame and the scheduled uplink and/or downlink transmission periods, e.g., to ensure that other communications are not performed during the reserved time period.

In some demonstrative embodiments, wireless communication unit **108** (FIG. 1) may reserve the wireless communication medium by transmitting, e.g., prior to transmitting frame **320**, at least one Request-To-Send (RTS) packet **301** to one or more wireless communication devices of the scheduled group, e.g., group **140** (FIG. 1). The RTS packet **301** may include a duration value corresponding to the time period to be reserved. For example, a duration field of the RTS packet may be set by wireless communication unit **108** (FIG. 1) to include a value representing a time period including the transmission period of frame **320**, and periods **313** and **315**. Wireless communication unit **108** (FIG. 1) may receive at least one Clear-to-Send (CTS) packet from at least one of the wireless communication devices of the scheduled group, e.g., in response to RTS packet **301**. For example, wireless communication unit **108** (FIG. 1) may receive CTS packets **303** and/or **305** from wireless communication devices **134** and/or **136** (FIG. 1), respectively. As shown in FIG. 3, in one embodiment, wireless communication unit **108** (FIG. 1) may simultaneously receive CTS packets **303** and/or **305**, e.g., as part of an uplink SDMA transmission. In other embodiments, wireless communication unit **108** (FIG. 1) may sequentially receive CTS packets **303** and/or **305**, for example, at an order defined by the AIDs list, e.g., as described above.

Reference is made to FIG. 4, which schematically illustrates a method of scheduling communication with a group of wireless communication devices, in accordance with some demonstrative embodiments.

In some demonstrative embodiments, one or more of the operations of the method of FIG. 3 may be performed by a wireless communication device, for example, wireless communication device **102** (FIG. 1), a wireless communication unit, e.g., wireless communication unit **108** (FIG. 1) and/or any other wireless communication device capable coordinating transmissions within a network.

As indicated at block **402**, the method may include assigning wireless communication devices to at least one group. For example, wireless communication unit **108** (FIG. 1) may assign wireless communication devices **144**, **146** and/or **148** (FIG. 1) to group **140** (FIG. 1) and/or wireless communication devices **134**, **136** and/or **138** (FIG. 1) to group **130** (FIG. 1), e.g., as described above.

As indicated at block **420**, assigning the wireless communication devices to at least one group may include assigning the wireless communication devices based on TSPEC information corresponding to the wireless communication devices. For example, wireless communication devices **144**, **146** and/or **148** (FIG. 1) to group **140** (FIG. 1) and/or wireless communication devices **134**, **136** and/or **138** (FIG. 1) to group **130** (FIG. 1) based on TSPEC information corresponding to wireless communication devices **134**, **136**, **138**, **144**, **146** and/or **148** (FIG. 1), e.g., as described above.

As indicated at block **422**, the method may include providing to the wireless communication devices, which are assigned to a group, information corresponding to the group. For example, wireless communication unit **108** (FIG. 1) may transmit one or more allocation frames to wireless communication devices **134**, **136**, **138**, **144**, **146** and/or **148** (FIG. 1), e.g., as described above.

As indicated at block **404**, the method may include scheduling one or more communication periods for com-

munication with the wireless communication devices of a scheduled group. For example, wireless communication unit **108** (FIG. 1) may schedule one or more PSMP-DTT and/or PSMP-UTT periods for group **130** (FIG. 1) and/or one or more PSMP-DTT and/or PSMP-UTT periods for group **140** (FIG. 1), e.g., as described above.

As indicated at block **424**, scheduling the communication periods may include reserving a wireless communication medium for a duration corresponding to the communication periods. For example, wireless communication unit **108** (FIG. 1) may transmit RTS packet **301** (FIG. 3) to at least one wireless communication device of the scheduled group and/or receive CTS packets **303** and/or **305** (FIG. 3) from one or more wireless communication devices of the scheduled group, e.g., as described above.

As indicated at block **410**, scheduling the communication periods may include transmitting at least one scheduling frame to the scheduled group. For example, wireless communication unit **108** (FIG. 1) may transmit PSMP scheduling frame **200** (FIG. 2) to one or more wireless communication devices of group **130** (FIG. 1) to schedule the communication periods for group **130** (FIG. 1), e.g., as described above.

As indicated at block **426**, transmitting the scheduling frame may include transmitting an indication of the scheduled group. For example, wireless communication unit **108** (FIG. 1) may transmit PSMP frame **200** (FIG. 2) including the group address assigned to group **130** (FIG. 1), e.g., as described above.

As indicated at block **428**, transmitting the scheduling frame may include transmitting an indication of at least one downlink period, e.g., a SDMA downlink transmission period. For example, wireless communication unit **108** (FIG. 1) may transmit frame **200** (FIG. 2) including PSMP-DTT start offset and/or PSMP-DTT duration fields including values defining at least one PSMP-DTT period, e.g., as described above.

As indicated at block **430**, transmitting the scheduling frame may include transmitting an indication of at least one uplink period. For example, wireless communication unit **108** (FIG. 1) may transmit frame **200** (FIG. 2) including PSMP-UTT start offset and/or PSMP-UTT duration fields including values defining at least one PSMP-UTT period, e.g., as described above.

As indicated at block **412**, the method may include communicating during one or more of the scheduled communication periods.

As indicated at block **432**, communicating during one or more of the scheduled communication periods may include simultaneously transmitting two or more different wireless communication transmissions from the wireless communication unit to two or more respective wireless communication devices of the scheduled group during the downlink period. For example, wireless communication unit **108** (FIG. 1) may simultaneously transmit different downlink transmissions **320** (FIG. 3) to two or more wireless communication devices of the scheduled group, e.g., as described above.

As indicated at block **434**, communicating during one or more of the scheduled communication periods may include receiving wireless communication transmissions during the uplink period. For example, wireless communication unit **108** (FIG. 1) may receive simultaneous uplink transmissions **328** and **330** (FIG. 3) and/or sequential uplink transmissions **332** and **334** (FIG. 3) from two or more wireless communication devices of the scheduled group, e.g., as described above.



Reference is made to FIG. 5, which schematically illustrates an article of manufacture 500, in accordance with some demonstrative embodiments. Article 500 may include a machine-readable storage medium 502 to store logic 504, which may be used, for example, to perform at least part of the functionality of wireless communication unit 108 (FIG. 1) and/or wireless communication device 102 (FIG. 1); and/or to perform one or more operations of the methods of FIG. 4.

In some demonstrative embodiments, article 500 and/or machine-readable storage medium 502 may include one or more types of computer-readable storage media capable of storing data, including volatile memory, non-volatile memory, removable or non-removable memory, erasable or non-erasable memory, writeable or re-writable memory, and the like. For example, machine-readable storage medium 502 may include, RAM, DRAM, Double-Data-Rate DRAM (DDR-DRAM), SDRAM, static RAM (SRAM), ROM, programmable ROM (PROM), erasable programmable ROM (EPROM), electrically erasable programmable ROM (EEPROM), Compact Disk ROM (CD-ROM), Compact Disk Recordable (CD-R), Compact Disk Rewritable (CD-RW), flash memory (e.g., NOR or NAND flash memory), content addressable memory (CAM), polymer memory, phase-change memory, ferroelectric memory, silicon-oxide-nitride-oxide-silicon (SONOS) memory, a disk, a floppy disk, a hard drive, an optical disk, a magnetic disk, a card, a magnetic card, an optical card, a tape, a cassette, and the like. The computer-readable storage media may include any suitable media involved with downloading or transferring a computer program from a remote computer to a requesting computer carried by data signals embodied in a carrier wave or other propagation medium through a communication link, e.g., a modem, radio or network connection.

In some demonstrative embodiments, logic 504 may include instructions, data, and/or code, which, if executed by a machine, may cause the machine to perform a method, process and/or operations as described herein. The machine may include, for example, any suitable processing platform, computing platform, computing device, processing device, computing system, processing system, computer, processor, or the like, and may be implemented using any suitable combination of hardware, software, firmware, and the like.

In some demonstrative embodiments, logic 504 may include, or may be implemented as, software, a software module, an application, a program, a subroutine, instructions, an instruction set, computing code, words, values, symbols, and the like. The instructions may include any suitable type of code, such as source code, compiled code, interpreted code, executable code, static code, dynamic code, and the like. The instructions may be implemented according to a predefined computer language, manner or syntax, for instructing a processor to perform a certain function. The instructions may be implemented using any suitable high-level, low-level, object-oriented, visual, compiled and/or interpreted programming language, such as C, C++, Java, BASIC, Matlab, Pascal, Visual BASIC, assembly language, machine code, and the like.

Functions, operations, components and/or features described herein with reference to one or more embodiments, may be combined with, or may be utilized in combination with, one or more other functions, operations, components and/or features described herein with reference to one or more other embodiments, or vice versa.

While certain features of the invention have been illustrated and described herein, many modifications, substitu-

tions, changes, and equivalents may occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

What is claimed is:

1. An apparatus comprising:

a processor;

a memory; and

a wireless communication unit configured to transmit at least one scheduling frame comprising an indication of a downlink period allocated for simultaneous transmission from the wireless communication unit to at least one group of a plurality of wireless communication devices, and to simultaneously transmit a plurality of different wireless communication transmissions to the plurality of wireless communication devices of the group during the downlink period, wherein, prior to transmitting the scheduling frame, the wireless communication unit is to reserve a wireless communication medium for a duration period including at least a duration of the scheduling frame and the downlink period.

2. The apparatus of claim 1, wherein the scheduling frame comprises an indication of at least one uplink period allocated for transmissions from the group of wireless communication devices to the wireless communication unit.

3. The apparatus of claim 2, wherein the wireless communication unit is to simultaneously receive a plurality of different uplink transmissions from the plurality of wireless communication devices of the group during the uplink period.

4. The apparatus of claim 2, wherein the wireless communication unit is to reserve the wireless communication medium for a duration period including at least a duration of the scheduling frame, the downlink period, and the uplink period.

5. The apparatus of claim 1, wherein the wireless communication unit is to transmit the plurality of wireless communication transmissions in the form of a space-division-multiple-access transmission.

6. The apparatus of claim 1, wherein the wireless communication unit is to transmit the plurality of wireless communication transmissions in different directions on a same frequency.

7. The apparatus of claim 1, wherein the scheduling frame comprises a group address ID field to indicate an address assigned to the group of wireless communication devices.

8. The apparatus of claim 1 comprising a transmitter and a receiver.

9. The apparatus of claim 1 comprising one or more antennas.

10. A product comprising one or more tangible computer-readable non-transitory storage media comprising computer-executable instructions operable to, when executed by at least one processor, enable the at least one processor to cause a wireless communication device to:

transmit at least one scheduling frame comprising an indication of a downlink period allocated for simultaneous transmission from the wireless communication device to at least one group of a plurality of wireless communication devices, the instructions, when executed, cause the wireless communication device to, prior to transmitting the scheduling frame, reserve a wireless communication medium for a duration period including at least a duration of the scheduling frame and the downlink period; and

simultaneously transmit a plurality of different wireless communication transmissions to the plurality of wireless communication devices of the group during the downlink period.

**11.** The product of claim **10**, wherein the scheduling frame 5 comprises an indication of at least one uplink period allocated for transmissions from the group of wireless communication devices to the wireless communication device.

**12.** The product of claim **11**, wherein the instructions, when executed, cause the wireless communication device to 10 simultaneously receive a plurality of different uplink transmissions from the plurality of wireless communication devices of the group during the uplink period.

**13.** The product of claim **11**, wherein the instructions, when executed, cause the wireless communication device to 15 reserve the wireless communication medium for a duration period including at least a duration of the scheduling frame, the downlink period, and the uplink period.

**14.** The product of claim **10**, wherein the instructions, when executed, cause the wireless communication device to 20 transmit the plurality of wireless communication transmissions in the form of a space-division-multiple-access transmission.

**15.** The product of claim **10**, wherein the instructions, when executed, cause the wireless communication device to 25 transmit the plurality of wireless communication transmissions in different directions on a same frequency.

**16.** The product of claim **10**, wherein the scheduling frame comprises a group address ID field to indicate an address assigned to the group of wireless communication 30 devices.

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